Psychology 9540. Research Design and Statistical Modeling (2021-2022)

COURSE OUTLINE

Instructor: Paul F. Tremblay, Ph.D.
email: ptrembla@uwo.ca
office hours: contact me by email to set appointment

Lectures: In person, in SSC 5220, Wednesdays 9:00am-12:00 noon (starting September 15th)
Course work: Bi-weekly written assignments (12 in total worth 100%).
Reading Resources: Rather than assign a specific textbook, I have prepared a list of suggested books, journal articles and book chapters all available electronically through our Western University library. I encourage you to examine these and focus on the material that you find the most helpful.

I. COURSE DESCRIPTION

My objective in this course is to help you develop your skills, experience, and confidence to design and conduct research from start to finish independently. I orient the content structure around three pillars of research: **research design, measurement, and statistical analysis**. In his book, *Becoming a Behavioral Science Researcher* (2020), Professor Rex B. Kline from Concordia University refers to these three "pillars" as the trinity of research.

The course content also consists of 24 topics organized into four general units:

- I. Fundamental and descriptive statistics (estimation, sampling distributions, data visualization and management, missing data techniques, inferential statistics, confidence intervals, effect size, replication, power analysis, and meta-analysis)
- II. General linear model and experimental designs with ANOVA, ANCOVA and MANOVA,
- III. Multiple Regression and extensions (including mediation, moderation, multilevel modeling, and models for categorical outcomes such as logistic regression)
- IV. Factor Analysis and Structural Equation Modeling with applications to measurement, test construction and construct validation.

I consider these 24 topics to be the building blocks of a solid foundation for statistical reasoning, research, and as preparation for more advanced quantitative courses.

The course work consists entirely of lab assignments that provide hands-on training by having you generate hypotheses, analyze data, interpret and report results, conduct simulations, write mini research proposals, and evaluate published research. My lectures and demonstrations include presentations in R (and the related Jamovi software), SPSS, and Mplus (for multilevel and structural equation modeling). Students are allowed to work in any other statistical or programming applications such as SAS, Python or MATLAB.

II. METHOD OF EVALUATION

Assignments: (100% of course grade).

- **Background preparation for labs**. Although I have never used formal tests or exams in this course, the lab assignments capture knowledge and ability to apply the content presented in the lectures. Students are responsible for keeping up with the weekly material.
- 12 bi-weekly assignments. The lecture schedule indicates when the assignments will be distributed, and you will have two weeks to complete an assignment.
- Most assignments will include data analysis, interpretation, discussion of results, and writing brief reports in APA style. A few assignments consist of developing mini research proposals and conducting power analyses or evaluating the procedures used in an article.
- Assignment reports will typically consist of a two double-spaced page write-up including a description, interpretation and discussion of your results, answers to specific questions, and an appendix with your analysis output.
- Late assignments will receive a 5% deduction per 24 hours. Assignments that are more than one week late will not be accepted for partial marks unless you have contacted me to request an extension.
- *Rules about working in groups*. I am supportive of students working in pairs or groups to conduct the analyses and discuss the assignments. However, you are required to write your own report with no duplication from your colleagues' work. The assignments will often require you to choose a subset of variables, to make decisions about plausible strategies, or to describe research ideas from your own area of interest. Also, some questions will ask you to design your own hypothetical research designs. As a result, it is unlikely that two students will work with the exact same material.

III. LECTURE SCHEDULE

	Date	Topic	Book Resources*	Lab
1	Sep 15	Overview, Philosophy of Science, Measurement	HV1, K1, K2	
2	Sep 22	Basic Statistics, Distributions, Confidence Intervals	HV 2,3,4	L 1
3	Sep 29	Inferential Statistics – Simulation and Power Analysis	HV 5, 6, K3, Ha27	
4	Oct 6	Data Inspection and Missing Data Analysis	K4, K9	L 2
5	Oct 13	t-tests, Robust Statistics and Effect Size	HV7, K5, Ha6	
6	Oct 20	One-way ANOVA and Research Design	HV11, 9, 12, K6, Ha1	L 3
7	Oct 27	Factorial ANOVA and Interactions	HV13, K7, Ha1	
8	Nov 10	Repeated Measures and Analysis of Change	HV15, Ha2	L 4
9	Nov 17	Split Plot ANOVA and Randomized controlled Trials	HV15, Ha2	
10	Nov 24	Measures of Association and their Inferential Tests	HV 8, 10, Ha5	L 5
11	Dec 1	Introduction to Meta-Analysis	Ha19	
12	Dec 8	Bivariate Linear Regression	HV17 Da2	L 6
13	Jan 5	Multiple Correlation – Statistical Control Methods	HV18	
14	Jan 12	Multiple Regression (MR)	HV18, Ha23	L7
15	Jan 19	Categorical Predictors in MR, similarity to ANOVA	Da 9, 10	
16	Jan 26	ANCOVA – Comparison with Change Score Methods	HV14	L8
17	Feb 2	Moderation in MR	HV20, Ha18	
18	Feb 9	Mediation in MR and Extensions	HV20, Ha18	L9
19	Feb 16	Logistic Regression and Other Regression Models	HV19, Ha16	
20	Mar 2	Multilevel Modeling-I – Subjects Within Groups	Ha22	L10
21	Mar 9	Multilevel Modeling-II – Observations within Individuals	Ha22	
22	Mar 16	Factor Analysis	Ha8	L11
23	Mar 23	Confirmatory Factor Ana. & Structural Equation Mod.	Ha8, Ha33	
24	Mar 30	Measurement Theory (Classical and Item Response)	K8, Ha29	L12

*Chapter readings. HV refers to Hahs-Vaughn & Lomax (2020); K refers to Kline (2020); Ha refers to Hancock et al. (2019) and Da refers to Darlington & Hayes (2016). See also list of articles in a subsequent section.

IV. STATEMENT OF ACADEMIC OFFENCES

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

V. COURSE READINGS

I will use the following textbooks listed below throughout the course. These are available online through our Western library and can be accessed through the OWL course page. You will be able to download sections in pdf.

Darlington, R. B., & Hayes, A. F. (2016). *Regression Analysis and Linear Models: Concepts, Applications, and Implementation*. Guilford Publications.

Hahs-Vaughn, D. L. & Lomax, R. G. (2020). *An introduction to statistical concepts. Fourth Edition*. Routledge. 978-1138650558

Hancock, G. R., Stapleton, L. M., & Mueller, R. O. (2019). *The reviewer's guide to quantitative methods in the social sciences (Second edition.)*. Routledge.

Kline, R. B. (2019). *Becoming a Behavioral Science Researcher (Second edition)*. Guilford Press. 978-1462541287

A list of supplementary articles and book chapters (available electronically through the library system or in the OWL course website) are listed below by lecture topic. These are additional resources that may serve you beyond this course in your own research. I will discuss most of these in my lecture material.

1. Overview, Philosophy of Science and Measurement

Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., Rao, S. M., & Clinic, C. (2018). Journal article reporting standards for quantitative research in Psychology: The APA Publications and Communications Board Task Force Report. *American Psychologist*, *73(1)*, 3–25. http://dx.doi.org/10.1037/amp0000191

Morling, B., & Calin-Jageman, R. J. (2020). What psychology teachers should know about open science and the new statistics. *Teaching of Psychology*, *47*, 169-179. doi: 10.1177/0098628320901372

Smith, E. R. (2014). Research design. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology. 2nd edition.* (p. 27–48). Cambridge University Press.

2. Basic Statistics, Frequency and Sampling Distributions, and Confidence Intervals

Cumming G., & Finch, S. (2005). Inference by eye. Confidence intervals and how to read pictures of data. *American Psychologist*, *60*, 170-180. doi: 10.1037/0003-066X.60.2.170

DeCarlo, L. T. (1997). On the meaning and use of kurtosis. *Psychological Methods*, *2*, 292-307.

3. Inferential Statistics, Simulation and Power Analysis

Amrhein, V., Greenland, S., & McShane, B. (2019). Retire statistical significance (Comment). *Nature*, *567*, 305-307.

Lakens, D., & Caldwell, A. R. (2021). Simulation-Based Power Analysis for Factorial Analysis of Variance Designs. *Advances in Methods and Practices in Psychological Science*, *4(1)*. https://doi.org/10.1177/2515245920951503

Maxwell, S. E., Kelley, K., & Rausch, J. R. (2008). Sample size planning for statistical power and accuracy in parameter estimation. *Annual Review of Psychology*, *59*, 537-563. doi: 10.1146/annurev.psych.59.103006.093735

4. Data Inspection and Missing Data Analysis

Baraldi, A. N., & Enders, C. K. (2010). An introduction to modern missing data analyses. *Journal of School Psychology*, *48*, 5–37. doi: 10.1016/j.jsp.2009.10.001

Field, A. P., & Wilcox, R. R (2017). Robust statistical methods: A primer for clinical psychology and experimental psychopathology researchers. *Behaviour Research and Therapy*, *98*, 19-38. http://dx.doi.org/10.1016/j.brat.2017.05.013

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. doi: 10.1146/annurev.psych.58.110405.085530

5. T-tests, Robust Statistics, and Effect Sizes

Kelley, K., & Preacher, K. J., (2012). On effect size. *Psychological Methods*, *17*, 137-152. doi: 10.1037/a0028086

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *frontiers in Psychology*. doi: 10.3389/fpsyg.2013.00863

Lakens, D., Scheel, A. M., & Isager, P. M. (2018). Equivalence testing for psychological research: A Tutorial. *Advances in Methods and Practices in Psychological Science*, *1*, 259-269. doi: 10.1177/2515245918770963

6. One-way ANOVA and Research Design

Sauder, D. C., & DeMars C. E. (2019). An Updated recommendation for multiple comparisons. *Advances in Methods and Practices in Psychological Science*, *2*, 26-44. doi:10.1177/2515245918808784

Smith, E. R. (2014). Research design. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology. 2nd edition.* (p. 27–48). Cambridge University Press.

7. Factorial ANOVA and Interactions

Spinner, B., & Gabriel, R. M. (1981). Factorial analysis of variance with unequal cell frequencies. *Canadian Psychology*, *22*, 260-270.

Pierce, C. A., Block, R. A., & Aguinis, H. (2004). Cautionary note on reporting eta-squared values from multifactor ANOVA designs. *Educational and Psychological Measurement*, *64*, 916-924. doi: 10.1177/0013164404264848

8. Repeated Measures (Within-subjects design) and Analysis of Change

Atkinson, G. (2001). Analysis of repeated measurements in physical therapy research. *Physical Therapy in Sports*, *2*, 194-208. doi: 10.1054/ptsp.2001.0071

9. Split Plot ANOVA and Randomized Controlled Trials

Gibbons, R. D., Hedeker, D., & DuToit, S. (2010). Advances in analysis of longitudinal data. *Annual Review of Clinical Psychology*, *6*, 79-107. doi: 10.1146/annurev.clinpsy.032408.153550

Read, K. L. et al. (2013). Statistical Methods for use in the analysis of randomized clinical trials utilizing a pretreatment, posttreatment, follow-up (PPF) paradigm. In J. S. Comer & P. C. Kendall (Eds.), *The Oxford Handbook of Research Strategies for Clinical Psychology* (Vol. 1). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199793549.013.0014

10. Measures of Association and their Inferential Tests

de Winter, J. C. F., Gosling, S. D., & Potter, J. (2016). Comparing the Pearson and Spearman correlation coefficients across distributions and sample sizes: A tutorial using simulations and empirical data. *Psychological Methods*, *21*, 273-290. http://dx.doi.org/10.1037/met0000079

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160. doi:10.3758/BRM.41.4.1149

McHugh, M. L. (2013). The chi-square test of independence. *Biochemica Medica*, *23*, 143-149. http://dx.doi.org/10.11613/BM.2013.018

11. Introduction to Meta-Analysis

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews.

BMJ. British Medical Journal (International Ed.), 372, n160–n160. https://doi.org/10.1136/bmj.n160

Pigott, T. D., & Polanin, J. R. (2020). Methodological Guidance Paper: High-Quality Meta-Analysis in a Systematic Review. *Review of Educational Research*, *90(1)*, 24–46. https://doi.org/10.3102/0034654319877153

Schäfer T., & Schwarz, M. A. (2019). The Meaningfulness of effect sizes in psychological research: Differences between sub-disciplines and the impact of potential biases. *Frontiers in Psychology, 10*, 813. doi: 10.3389/fpsyg.2019.00813

12. Bivariate Linear Regression

See book chapters

13. Multiple Correlation – Methods of "Statistical Control"

Becker, T. E. (2005). Potential problems in the statistical control of variables in organizational research: A qualitative analysis with recommendations. *Organizational Research Methods*, *8*, 274-289. doi: 10.1177/1094428105278021

Rohrer, J. M. (2018). Thinking clearly about correlations and causation: Graphical causal models for observational research. *Advances in Methods and Practices in Psychological Science, 1*, 27-42. DOI: 10.1177/2515245917745629

14. Multiple Regression

Hoyt, W. T., Leierer, S., & Millington, M. J. (2006). Analysis and interpretation of findings using multiple regression techniques. *Rehabilitation Counseling Bulletin*, *49*, 223-233.

Hoyt, W. T., Imel, Z. E., & Chan, F. (2008). Multiple regression and correlation techniques: Recent controversies and best practices. *Rehabilitation Psychology*, *53*, 321-339. doi: 10.1037/a0013021

Williams, M. N., Gomez Grajales, C. A., & Kurkiewicz, D. (2013). Assumptions of multiple regression. Correcting two misconceptions. *Practical Assessment, Research & Evaluation*, *18(11)*. Available online: https://pareonline.net/getvn.asp?v=18&n=11.

15. Categorical Predictors in Multiple Regression, Similarity to ANOVA

See book chapters

16. ANCOVA – Comparison with Change Score Procedures

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology*, *110*, 40-48. doi: 10.1037//0021-843X.110.1.40

Wright, D. B. (2006). Comparing groups in a before-after design: when t test and ANCOVA produce different results. *British Journal of Educational Psychology*, *76*, 663-675. DOI:10.1348/000709905X52210

17. Moderation in Multiple Regression

Hayes, A. F., & Rockwood, N. J., (2016). Regression based statistical mediation and moderation analysis in clinical research: Observations, recommendations and implementation. *Behaviour Research and Therapy*, 1-19. http://dx.doi.org/10.1016/j.brat.2016.11.001

18. Mediation in Multiple Regression

Hayes, A. F., & Rockwood, N. J., (2016). Regression based statistical mediation and moderation analysis in clinical research: Observations, recommendations and implementation. *Behaviour Research and Therapy*, 1-19. http://dx.doi.org/10.1016/j.brat.2016.11.001

Schoemann, A. M., Boulton, A. J., & Short, S. D. (2017). Determining power and sample size for simple and complex mediation models. *Social Psychological and Personality Science*, *8*, 379-386. DOI: 10.1177/1948550617715068

Hayes, A. F., & Rockwood, N. J. (2020). Conditional process analysis: concepts, computation, and advances in the modeling of the contingencies of mechanisms. *American Behaviorist Scientist*, 64(1), 19-54. DOI: 10.1177/0002764219859633

19. Logistic Regression and Other Regression Models

Coxe, S., West, S. G., Aiken L. S. (2009). The analysis of count data: A gentle introduction to poisson regression and its alternatives. *Journal of Personality Assessment*, *91*, 121-136. doi: 10.1080/00223890802634175

Huang, F. L., & Moon, T. R. (2013). What are the odds of that? A primer on understanding logistic regression. *Gifted Child Quarterly*, *57*, 197-204. doi: 10.1177/0016986213490022

20. Multilevel Modeling-I – Subjects Within Groups

Nezlek, J. B. (2008). An introduction to multilevel modeling for social and personality psychology. *Social and Personality Psychology Compass*, 2(2), 842-860.

Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, *48*, 85-112. doi:10.1016/j.jsp.2009.09.002

21. Multilevel Modeling-II – Observations within Individuals

Peugh, J. L. (2010). A practical guide to multilevel modeling. Journal of School Psychology, 48, 85-112. doi:10.1016/j.jsp.2009.09.002

Gibbons, R. D., Hedeker, D., & DuToit, S. (2010). Advances in analysis of longitudinal data. *Annual Review of Clinical Psychology*, *6*, 79-107. doi: 10.1146/annurev.clinpsy.032408.153550

22. Factor Analysis

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*, 272-299. doi: 10.1037//1082-989X.4.3.272

Preacher, K. J., & MacCallum, R. C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding Statistics*, *2*, 13-43.

Watkins, M. W. (2018). Exploratory factor analysis: A guide to best practice. *Journal of Black Psychology*, *44*, 219-246. doi: 10.1177/0095798418771807

23. Confirmatory Factor Analysis and Structural Equation Modeling

Weston, R. & Gore Jr, P. A. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist*, *34*, 719-751. doi: 10.1177/0011000006286345

Whitley, B. E., & Kite, M. E. (2018). *Principles of Research in Behavioral Science*. Fourth Edition. NY: Routledge. See chapter 12: Factor analysis, path analysis, and structural equation modeling.

24. Measurement Theory (Classical and Item Response)

DeVellis, R. F. (2006). Classical test theory. *Medical Care*, *44*, S50 S59. http://www.jstor.org/stable/41219505

Toland, M. D. (2014). Practical guide to conducting an item response theory analysis. *Journal of Early Adolescence*, *34*, 120-151. doi: 10.1177/0272431613511332

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, *7*, 309-319. doi: 10.1037/1040-3590.7.3.309

Clark, L. A., & Watson, D. (2019, March 21). Constructing validity: New developments in creating objective measuring instruments. *Psychological Assessment*. Advance online publication. http://dx.doi.org/10.1037/pas0000626

Health/Wellness Services
Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Accessible Education Western (AEW)
Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program.

Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW), a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.